RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2021 – 2022

DEPARTMENT OF BIOTECHNOLOGY

III & IV SEMESTER B.E

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
Bangalore – 560054.

About the Institute

Dr. M. S. Ramaiah a philanthropist, founded 'Gokula Education Foundation' in 1962 with an objective of serving the society. M S Ramaiah Institute of Technology (MSRIT) was established under the aegis of this foundation in the same year, creating a landmark in technical education in India. MSRIT offers 17 UG programs and 15 PG programs. All these programs are approved by AICTE. All eligible UG and PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with **'A^{+}' grade by NAAC in March 2021** for 5 years. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs since 2007. The institute is a participant to the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. The institute has 380 competent faculty out of which 60% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility for all faculty members, all research departments active with sponsored funded projects and more than 300 scholars pursuing Ph.D. To promote research culture, the institute has established Centre of Excellence for Imaging Technologies, Centre for Advanced Materials Technology, Centre for Antennas and Radio Frequency systems (CARFS), Center for Cyber Physical Systems & Schneider Centre of Excellence. **M S Ramaiah Institute of Technology has obtained "Scimago Institutions Rankings" All India Rank 65 & world ranking 578 for the year 2020.**

The Entrepreneurship Development Cell (EDC) and Section 8 company "Ramaiah Evolute" have been set up on campus to incubate startups. **M S Ramaiah Institute of Technology secured All India Rank 8th for the year 2020 for Atal Ranking of Institutions on Innovation Achievements (ARIIA), by MoE, Govt. of India.** MSRIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with good collection of book volumes and subscription to International and National Journals. The Digital Library subscribes to online e-journals from Elsevier Science Direct, IEEE, Taylor & Francis, Springer Link, etc. MSRIT is a member of DELNET, CMTI and VTU E-Library Consortium. MSRIT has a modern auditorium and several hi-tech conference halls with video conferencing facilities. The institute has excellent hostel facilities for boys and girls. MSRIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association.

As per the National Institutional Ranking Framework (NIRF), MoE, Government of India, M S Ramaiah Institute of Technology has achieved 65th rank among 1143 top Engineering institutions of India for the year 2021 and is 1st amongst the Engineering colleges affiliated to VTU, Karnataka.

About the Department

The department of Biotechnology established in 2002 offers a four year B.E. Biotechnology Program with an intake of 60 students and a two years PG Program, M.Tech in Biotechnology with an intake of 18 students. The department is a recognized Research Centre by VTU, Belgaum, offering M.Sc (Engg.) by research and PhD programs. The Department also offers a Post Graduate Diploma in Biopharmaceutical Technology under the Biotechnology Skill Enhancement Programme (BiSEP), supported by the Department of IT & BT, Government of Karnataka with a sanctioned budget of Rs. 162.5 Lakhs.

The department has 14 faculty members, of them 13 are PhD holders. The faculty members have competence in Core areas of Biotechnology viz. Food and Agricultural Biotechnology, Health and Medical Biotechnology & Environmental Biotechnology and Bioprocess Engineering. The department research is focused towards these core areas and funded by national and state funding agencies like DST, KBITS, AICTE, VGST, VTU and RGUHS.

The department faculties and students have publications in Scopus indexed peer reviewed journals of Elsevier, Taylor and Francis, Springer etc. Faculties have published book chapters and presented their research work in national and international conferences. A sizeable number of students have pursued their higher education at various premier institutes in India and abroad after having qualified GATE, GRE & TOEFL exams. The students undergo internships at various premier institutes in India and abroad. Several students receive the Indian Science Academies Summer Internship every year. The department has collaborations with some of the leading biotech industries like: Biocon, Hindustan Unilever Limited (HUL), Bristol Myers Squibb India Ltd, Novozymes South Asia Pvt Ltd, Himalaya Drug Company, Beckman Coulter, Sami Labs, Sartorius AG, Genotypic Technology, Aristogene Biosciences, GangaGen, Connexios Life Sciences, Acquity Labs & Celest Pharma.

VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio-economic needs.

MISSION OF THE INSTITUTE

RIT shall meet the global socio-economic needs through

1. Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization.
2. Establishing research clusters in emerging areas in collaboration with globally reputed organizations.
3. Establishing innovative skills development, techno-entrepreneurial activities and consultancy for socio-economic needs.

QUALITY POLICY

We at Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stakeholders concerned

VISION OF THE DEPARTMENT

To be a leading Biotechnology Engineering department that imparts quality technical education with strong research component, to develop solutions in the field of food, health and environment.

MISSION OF THE DEPARTMENT

To provide quality technical education in a conducive learning environment to produce professionals, researchers with a zeal for lifelong learning and a commitment to society.

Programme Educational Objectives (PEOs) of the program

PEO 1: To impart strong foundation in mathematics, basic and engineering sciences contributing to Biotechnology.

PEO 2: To produce graduates who can pursue higher education and research in biotechnology and allied fields.

PEO 3: To produce graduates with an ability to design, develop and implement research projects and apply to solve problems related to areas of biotechnology.

PEO 4: To provide opportunities to students to work in multidisciplinary teams with professional ethics, good communication, leadership skills and commitment to society.

Programme Outcomes (PO): As per NBA guidelines

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

1. To have thorough grounding in Mathematics, Chemistry and Biology.
2. To be proficient in the principles and practices of advanced biological sciences.
3. To apply engineering principles to biological systems to solve Biotechnology problems.

SEMESTER WISE CREDIT BREAKDOWN

BATCH: 2020-2024

Category	Semester								Total
	I	II	III	IV	V	VI	VII	VIII	
Basic Sciences (BSC)	9	8	4	4					25
Engineering Sciences (ESC)	11	10							21
Humanities, Social Sciences and Management (HSMC)		2			3		3		8
Professional Courses-Core (PCC)			21	21	15	11	10		78
Professional Courses-Elective (PEC)					3	6	6		15
Other Open Elective Courses (OEC)					3	3			6
Seminar (SE), Project Work (PROJ), Internship (IN)						4	1	17	22
Total	**20**	**20**	**25**	**25**	**24**	**24**	**20**	**17**	**175**

SCHEME OF TEACHING
III Semester

Sl. No.	Course Code	Course	Category	Credits			
				L	T	P	Total
1.	BT31	Numerical and Mathematical Biology	BSC	3	1	0	4
2.	BT32	Unit Operations	PCC	4	0	0	4
3.	BT33	Bioprocess Principles and Calculations	PCC	3	1	0	4
4.	BT34	Biochemistry	PCC	4	0	0	4
5.	BT35	Microbiology	PCC	3	0	0	3
6.	BT36	Cell and Molecular Biology	PCC	4	0	0	4
7.	BTL37	Biochemistry Lab	PCC	0	0	1	1
8.	BTL38	Microbiology Lab	PCC	0	0	1	1
9.	AM31*	Additional Mathematics-I	BSC	0	0	0	3
Total				**21**	**2**	**2**	**25**

* Non-Credit Mandatory Course L – Lecture (one hour) T - Tutorial (Two hours) P - Practical (Two hours)

Note:

1. The Non-Credit Mandatory Course, Additional Mathematics – I is prescribed for III Semester Lateral Entry Diploma students admitted to III Semester of BE Program. The student shall register for this course along with other III semester courses. The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE to appear for SEE. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

2. AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):

Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years Degree Program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students 8th Semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. Incase student fail to earn the prescribed activity points; eight semester Grade Card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the Eight Semester grade card.

IV Semester

Sl. No.	Course Code	Course	Category	Credits			
				L	T	P	Total
1.	BT41	Biostatistics and Biomodelling	BSC	3	1	0	4
2.	BT42	Heat and Mass Transfer	PCC	4	0	0	4
3.	BT43	Biochemical Thermodynamics	PCC	3	1	0	4
4.	BT44	Genetics and Genetic Engineering	PCC	4	0	0	4
5.	BT45	Biophysics and Structural Biology	PCC	4	0	0	4
6.	BT46	Bioanalytical Techniques	PCC	3	0	0	3
7.	BTL47	Cell and Molecular Biology Lab	PCC	0	0	1	1
8.	BTL48	Unit Operations Lab	PCC	0	0	1	1
9.	AM41*	Additional Mathematics-II	BSC	0	0	0	3
Total				**21**	**2**	**2**	**25**

* Non-Credit Mandatory Course L – Lecture (one hour) T - Tutorial (Two hours) P - Practical (Two hours)

Note:

1. The Non-Credit Mandatory Course, Additional Mathematics – II is prescribed for IV Semester Lateral Entry Diploma students admitted to III Semester of BE Program. The student shall register for this course along with other IV semester courses. The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE to appear for SEE. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

2. AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):

Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years Degree Program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students 8th Semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. Incase student fail to earn the prescribed activity points; eight semester Grade Card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the Eight Semester grade card.

NUMERICAL AND MATHEMATICAL BIOLOGY

Course Code	**:** BT31	**Credits:**	3:1:0
Contact Hours	**:** 42L+14T		
Prerequisite(s)	**:** Calculus		
Course Coordinator(s)	**:** Dr. Monica Anand & Dr. Ramprasad S		

UNIT-I

Numerical solution of Algebraic and Transcendental equations: Method of false position, Newton - Raphson method.

Numerical solution of Differential equations: Taylor's series method, Euler's & modified Euler's method, fourth order Runge-Kutta method.

Statistics: Curve fitting by the method of least squares, Fitting linear, quadratic and geometric curves**,** Correlation and Regression lines, Multiple Regression

UNIT-II

Finite Differences and Interpolation: Forward and backward differences, Interpolation, Newton-Gregory forward and backward interpolation formulae, Lagrange's interpolation formula, Newton's divided difference interpolation formula (no proof).

Numerical Differentiation and Numerical Integration: Derivatives using Newton-Gregory forward and backward interpolation formulae, Newton-Cote's quadrature formula, Trapezoidal Rule, Simpson's $(1/3)^{rd}$ rule, Simpson's$(3/8)^{th}$ rule

UNIT-III

Linear Algebra: Elementary transformations on a matrix, Echelon form of a matrix, rank of a matrix, Consistency of system of linear equations, Gauss elimination and Gauss – Seidel method to solve system of linear equations, eigen values and eigen vectors of a matrix, Rayleigh power method to determine the dominant eigen value of a matrix, diagonalization of square matrices, solution of system of ODEs by matrix method

UNIT-IV

Partial Differential Equations: Classification of second order PDE, Numerical solution of one-dimensional heat and wave equations.

Finite Element Method: Introduction, element shapes, nodes and coordinate systems, Shape functions, assembling stiffness equations- Galerkin's method, Discretization of a structure, Applications to solve ordinary differential equations.

UNIT-V

Fourier Transforms: Infinite Fourier transform and properties, Fourier sine and cosine transforms

Models of flows for other Bio-fluids: Introduction to fluid dynamics, continuity equation for two and three dimensions in different coordinate systems, Navier-Stokes equations in different coordinate systems, Hagen-Poiseuille flow, special characteristics of blood flows, fluid flow in circular tubes, Stenosis and different types of stenosis, blood flow through artery with mild stenosis.

Textbooks:

1. B.S. Grewal – Higher Engineering Mathematics – Khanna Publishers – 44thedition – 2017.
2. J.N. Kapur – Mathematical Models in Biology and Medicine – East-West Press Private Ltd., New Delhi – 2010.
3. S.S. Bhavikatti – Finite Element Analysis –NewAge International Publishers – 2015.

Reference Books:

1. Dennis G. Zill, Michael R. Cullen – Advanced Engineering mathematic – Jones and Barlett Publishers Inc. – 4th edition – 2011.
2. S.S. Sastry – Introductory Methods of Numerical Analysis – Prentice Hall of India – 5th edition – 2012.
3. B.V. Ramana – Higher Engineering Mathematics-Tata McGraw Hill Publishing Company Ltd, New Delhi – 2008.

Course Outcomes (COs):

At the end of the course, students will be able to

1. Apply numerical techniques to solve engineering problems and fit a least squares curve to the given data. (PO-1,2 & PSO-1)
2. Find functional values, derivatives, areas and volumes numerically from a given data. (PO-1,2 & PSO-1)
3. Solve system of linear equations and ordinary differential equations using matrices. (PO-1,2 & PSO-1)
4. Solve partial differential equations numerically and ordinary differential equations using finite element method. (PO-1,2 & PSO-1)
5. Evaluate Fourier transforms of given functions and discuss models of Bio-fluid flows. (PO-1,2 & PSO-1)

UNIT OPERATIONS

Course Code	**:** BT32	**Credits:**	4:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Engineering Mathematics I and II		
Course Coordinator(s)	**:** Mr. M Gokulakrishnan and Dr. Chandraprabha M N		

UNIT-I

Introduction to Fluid Mechanics: Units, Dimensions, Basic and Derived units, Dimensional homogeneity, Dimensionless numbers, Rayleigh method, Buckingham's pi theorem, Similitude. Fluid definition and classification (Types of fluids – Newtonian and Non Newtonian); Rheological behaviour of fluids. Fluid statics and its applications- Hydrostatic equilibrium, Pressure measurement - Manometers.

UNIT-II

Flow Past Immersed Bodies: Types of flow - laminar and Turbulent; Reynolds number; Basic equations of fluid flow - Continuity equation and Bernoulli equation; Correction for Bernoulli's equation, Pump work in Bernoulli's equation; Flow through circular and non-circular conduits – Friction factor relations for smooth and commercial pipes, Hagen Poiseuille equation; Flow past immersed bodies – Kozney-Carmen equation, Burke Plummer equation.

UNIT-III

Flow measurements: Flow measurements – Orifice meter, Venturimeter, Rotameter. Pumps, Centrifugal & Reciprocating pumps, Characteristics of centrifugal pumps. Pipes, fittings and valves. Dimensional Analysis.

UNIT-IV

Mechanical Operations-I

Filtration: Types of filtrations, Filter media and filter aids, calculation of resistances and rate of filtration, filtration equipment.

Flow of Solids through Stagnant Fluids: Types of drag and Drag coefficient, Settling, Free and Hindered, Stoke's law, Newton's law, Terminal settling velocity, Batch sedimentation theory (Kynch), Thickener design.

UNIT-V

Mechanical Operations-II

Agitation: Theory of mixing, Power number calculations, Mixing equipment. Flow patterns in agitated tanks, mechanism of mixing, scale up of mixing systems.

Size Separation: Particle shape, size, screen analysis, screening equipment**.**

Size Reduction: Characteristics of comminute products, crushing laws and work index**;** Size reduction equipment

Material Handling Equipment: Material handling equipment, Transportation of materials and storage.

Textbooks:

1. McCabe WL, Smith JC and Harriott (2005) Unit operations of Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA.
2. Gavhane KA (2012) Unit Operations I & II, 22nd Edn., Nirali Prakashan, India.

Reference books:

1. Alan S Foust, Wenzel LA, Clump CW, Maus L, and Anderson LB (2008) Principles of Unit Operations. 3rd Edn., John Wiley & Sons, USA.
2. R. P. Chhabra V. Shankar (2017) Coulson and Richardson's Chemical Engineering Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Edition, Elsevier, USA.
3. R. P. Chhabra Basavaraj Gurappa (2019) Coulson and Richardson's Chemical Engineering Volume 2A: Particulate Systems and Particle Technology. 6th Edition, Elsevier, USA.

Course Outcomes (COs):

On completion of this course student will be able to:-

1. Predict the dimensional analysis and solution for fluid flow problems. (PO-1, 2, 4; PSO-1)
2. Predict the pressure drop in fluid flow and flow through packed beds. (PO-1, 2, 3, 4; PSO-3)
3. Estimate the flow rate of fluids and design the pumps for transportation of fluids. (PO-1, 2, 3, 4, 9; PSO-1)
4. Analyse and solve the problems on filtration and settling. (PO- 2, 3, 4; PSO-3)
5. Analyse the forces involved in flow through solids and its operations. (PO-1, 3; PSO-3)

BIOPROCESS PRINCIPLES AND CALCULATIONS

Course Code	**:** BT33	**Credits:**	3:1:0
Contact Hours	**:** 42L+14T		
Prerequisite(s)	**:** Engineering Mathematics I and II		
Course Coordinator(s)	**:** Dr. Chandraprabha M N and Dr. T P Krishna Murthy		

UNIT-I

Introduction & Basic Chemical Calculations: Historical development and overview of traditional and modern applications of biotechnological processes. Process flow sheet and unit operations in chemical and bioprocess industries. Fundamental and derived quantities, Inter-conversion of units from one system to another (FPS, CGS, MKS, SI**).** Concept of mole and molecule, Composition of mixtures and solutions- Percentage by weight, mole and volume; Normality, Molarity, Molality; average molecular weight; ppm, pH and pK Buffer calculations.

UNIT-II

Material balance without chemical reactions: General material balance equation for steady and unsteady states. Material balances in Distillation, Absorption, Extraction, Crystallization, Psychrometry, Drying, Mixing, Evaporation Operations.

UNIT-III

Material balance involving chemical reactions: Principles of Stoichiometry. Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, selectivity and related problems. Material balances involving bypass & recycle; Fuels and Combustion: calculations involving Excess air and Air-fuel ratio.

UNIT-IV

Energy Balance: General energy balance equation for steady state. Thermo physics and Thermo chemistry: Heat capacity, estimation of heat capacity for solids, liquids, gases and their mixtures. Enthalpy, Standard Heat of formation, standard heat of reaction, Standard heat of combustion and calorific value, Calculation of $\Delta(H_R)$ at elevated temperature. Heat effects of biochemical reactions**.**

UNIT-V

Stoichiometry of Microbial Growth and Product Formation: Introduction, Definitions of specific growth rate and yield**.** Elemental balances and degrees of

reduction. Problems on specific rate and yield, models of microbial growth, models with growth inhibitors, heat generation during microbial growth.

Textbooks:

1. P.M.Doran (2012) Bioprocess Engineering Principles, 2nd Edition, Elsevier India Pvt Ltd.
2. Gavhane KA (2009) Process Calculations Stoichiometry, 22nd Edn, Nirali Prakashan, India.
3. M.L.Shuler and F.Kargi (2008) Bioprocess Engineering--basic Concepts, 2nd Edn. Prentice-hall of India Pvt Ltd.

Reference Books:

1. Segel IH (2010) Biochemical Calculations 2nd Edn., John Wiley & Sons, NewYork.
2. Bailey JE and Ollis DF (1993) Biochemical Engg. Fundamentals, McGraw Hill, Newyork, USA.
3. Narayanan K V, Lakshmikutty B (2016) Stoichiometry and Process Calculations, 2nd Edition, PHI India.
4. D.M. Himmelblau (2014) Basic Principles and Calculations in Chemical Engineering, 8th Edn, PHI LEARNING PVT LTD.
5. Bhatt, B. I., and Thakore, S. B. (2010). Stoichiometry. Tata McGraw-Hill Education.

Course Outcomes (COs):

On completion of this course student will have improved ability to

1. Conduct unit conversions and basic chemical calculations. (PO-1, 4; PSO-1)
2. Conduct material balances around steady- state multi-unit processes without chemical reactions. (PO- 1, 2, 3, 4; PSO-1, 3)
3. Conduct material balances around steady- state multi-unit processes with chemical reactions. (PO-1, 2, 3, 4; PSO-1, 3)
4. Conduct energy balances around multi-unit processes with and without chemical reactions. (PO-1, 2, 3, 4; PSO-1, 3)
5. Predict stoichiometric requirements of reactants and products in biochemical reactions. (PO-1, 4; PSO-1, 3)

BIOCHEMISTRY

Course Code	**:** BT34	**Credits:**	4:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Engineering Chemistry		
Course Coordinator(s)	**:** Dr. P. Dhamodhar & Dr. Ahalya N		

UNIT-I

Introduction to Biomolecules: Carbohydrates, Fats and lipids, Amino acids and Proteins. Structure, Properties and Classification. Biologically important peptides, Purines, pyrimidines, nucleotides, Nucleic Acids- DNA and RNA.

UNIT-II

Bioenergetics & Transport Mechanism: Energy, energy flow cycle, Structure and properties of ATP. High energy compounds, Coupling reactions of ATP and NAD. Biological membranes: structure, permeability, properties, passive transport and active transport, facilitated transport, energy requirement, mechanism of Na+ / K+, glucose and amino acid transport. Organization of transport activity in cell.

UNIT-III

Carbohydrate Metabolism: Glycolysis – Aerobic and anaerobic pathway and energetics, TCA cycle and its regulation, Calvin Cycle, Glyoxylate cycle, Pentose Phosphate Pathway. Electron transport chain and oxidative phosphorylation, Gluconeogenesis –regulation of gluconeogenesis. Biosynthesis of polysaccharides.

UNIT-IV

Lipid Metabolism: Biosynthesis of fatty acids, Fatty acid synthase, Biosynthesis of cholesterol, phospholipids, glycolipids. Biodegradation of fatty acids-beta oxidation pathway and its energetics.

UNIT-V

Amino Acid & Nucleotide Metabolism: Biosynthesis of amino acids starting from acetyl CoA (with reference to oxaloacetate family). Biodegradation of amino acids, deamination, transamination and urea cycle. Biosynthesis, and biodegradation of Purine & pyrimidine nucleotides: Denovo pathway, salvage pathway. Regulation of nucleotide metabolism.

Textbooks:

1. David L. Nelson, Michel M. Cox (2008) Lehninger Principles of Biochemistry,4th Edn., Palgrave Macmilan, W H Freeman Publisher, Newyork, USA.
2. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer (2006) Biochemistry, 6th Edn. W H Freeman Publisher, New York, USA.

Reference Books:

1. Donal J. Voet, Judith G. Voet, Charlotte W. Pratt (2005) Fundamentals of Biochemistry, Upgrade Edn. Wiley Publishers, New York, USA.
2. Robert K Murray, Daryl K Granner, Peter A Mayes (2006) Harper's Illustrated Biochemistry 27th Edn. McGraw Hill Book Company, USA.

Course Outcomes (COs):

On completion of this course student will have improved ability to:-

1. Classify the macromolecules and analyze the structure, functions and their properties. (PO-1; PSO-1)
2. Differentiate between various biological transport processes and bioenergetics. (PO-1, 2, 4; PSO-1)
3. Analyze the importance of carbohydrate metabolism in human body. (PO-1, 4; PSO-1)
4. Analyze the importance of Lipid metabolism in human body. (PO-1; PSO-1)
5. Analyze the importance of Amino acid and nucleotide metabolism in human body. (PO-1; PSO-1)

MICROBIOLOGY

Course Code	**:** BT35	**Credits:**	3:0:0
Contact Hours	**:** 42L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. Ahalya N and Dr. P. Dhamodhar		

UNIT-I

Introduction to Microbiology and Study of Microorganisms: Scope of microbiology, History of microbiology, Origin of life, Prokaryotes and Eukaryotes. Microbial Diversity and Taxonomy. Structure, Classification and Reproduction of Bacteria, Fungi, Viruses, Protozoa and Algae.

UNIT-II

Methods and Techniques in Microbiology: Microscopy: Concepts, Light Microscopy - Bright-Field Microscopy, Dark-Field Microscopy, Phase-Contrast Microscopy, Fluorescence Microscopy, Preparation and Staining of Specimens, Electron Microscopy – Scanning and Transmission Electron Microscopy, Atomic Force Microscopy, Confocal Microscopy, Characterization: Biochemical tests and 16-s rRNA homology studies. Culture methods - pure culture techniques

UNIT-III

Microbial Growth and Metabolism: Growth curve patterns, Physical conditions required for growth, Nutritional requirements, Media preparation, types of media, Maintenance and Preservation of Microorganisms, Microbial Metabolism: Aerobic and anaerobic growth, Metabolic pathways.

UNIT-IV

Microbial Control: Control of Microorganisms by physical methods (heat, filtration, radiation), Control by chemical methods (phenol & phenolic compounds, Alcohols, Halogens, Dyes, Detergents, Aldehydes, Heavy metals, etc), Antibiotics and other chemotherapeutic agents.

UNIT-V

Applications of Microbiology: Microbiology of soil, Biofertilizers, Microbes in Bioremediation, Microbes as source of protein, Microbial Insecticides, Enzymes from microbes, primary and secondary metabolites. Pathogenesis of microorganisms, Human diseases caused by microbes - Viruses (HIV, hepatitis B & C, Influenza virus), Bacteria (TB, Cholera), Protozoans (Malaria).

Textbooks:

1. Prescott LM, Harley JP, Klein DA (2012) Microbiology, 8th Edn. McGraw- Hill Publications, USA
2. Pelczar MJ, Chan ECS, Kreig NR (1993) Microbiology, 5th Edn. Tata Mc-Graw Hill, India.

Reference Books:

1. Black J (2010) Microbiology: Principles and Explorations, 7th Edn. John Wiley and Sons, USA.
2. Tortora GJ, Funke BR, and Case CL (2012) Microbiology: An Introduction, 6th Edn., Benjamin-Cummings Pub Co, USA.
3. Ingraham JA, Ingraham CA (2004) Introduction to Microbiology, 3rd Edn. Int Thomson Computer Press, USA.

Course Outcomes (COs):

On completion of this course student will have improved ability to

1. Demonstrate the knowledge of different types of microorganisms, their classification, modes of reproduction and significance. (PO-1, 2, 3; PSO – 1)
2. Describe the techniques of microscopy and isolate and identify the microorganisms. (PO-1, 2, 3; PSO – 1, 2)
3. Discuss the microbial growth and metabolism (PO-1, 2, 3; PSO – 1)
4. Evaluate and apply the various microbial control measures. (PO-1, 2, 3; PSO – 1, 3)
5. Analyse the role of microorganisms in the field in the field of environment, food and medicine. (PO-1, 3; PSO – 1, 3)

CELL AND MOLECULAR BIOLOGY

Course Code	**:** BT36	**Credits:**	4:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. Ravi Kumar Y. S. and Dr. Prabha M.		

UNIT-I

Cell Structure & Function: Introduction and scope of cell biology; Evolution of prokaryotic & eukaryotic cells; Structural organization and functions of cell organelles: Nucleus, Mitochondria, Chloroplast, Endoplasmic reticulum, Golgi bodies, Ribosomes, Lysosomes, Peroxisomes, Vacuoles. Cytoskeleton – eukaryotic & prokaryotic; eukaryotic cytoskeletal proteins – types, structural organization and functions.

UNIT-II

Protein trafficking: general membrane transport mechanisms, transport of molecules between the nucleus and the cytosol the transport of proteins into mitochondria and chloroplasts, protein transport to endoplasmic reticulum.

Cell Cycle & Cell Signalling: Cell-Cell junctions. Cell cycle; Mitosis and Meiosis. Introduction to cell signalling- para, endo and autocrine; different Receptors: cell surface, ion channel linked; neurotransmitter, G protein linked; beta adrenergic receptor, cAMP and enzyme linked; Ras-DAG, calmodulin.

UNIT-III

Introduction to Molecular Biology and DNA Replication: Scope of molecular biology. Genomes- genetic material, gene structure and functions. Concept of central dogma of molecular biology. replication: origin and site and structure DNA polymerases, composition and features, replication factors and the mechanism of replication, leading strand and lagging strand synthesis, Termination replication. Eukaryotic-replication origins, DNA polymerases and their composition, replication initiation complexes and their assembly, licensing factors, telomerase and mode of action, replication factors, Replication fidelity.

UNIT-IV

Prokaryotic Transcript: Promotor and their structure, *E. coli* RNA polymerase, Initiation, functions of σ factors, elongation, termination. Eukaryotic transcription: types of RNA polymerases and promoters. RNA Pol II structure and subunit functions. General transcription factors, mechanism of Initiation, elongation, termination, rRNAs;

Structural features of rRNAs- prokaryotic and eukaryotic. tRNAs: structural features, their anticodon feature. mRNAs- prokaryotic and eukaryotic mRNAs, structural feature. **RNA Processing:** exons & introns, splicing, spliceosomes, snRNPs, self-splicing introns, Alternative splicing, capping, polyadenylation. RNA editing, transsplicing.

UNIT-V

Translation: Ribosome structure & function, mechanism of prokaryotic and eukaryotic translation, role of initiation elongation and termination factors, genetic code. Protein folding: molecular chaperon, HSP 70 and Gro EL/Groes complex. Post translational modification:

Regulation of prokaryotic genes expression: Operons and their types, Regulation of Lac operon, Tryptophan operon. Genetic regulation of sporulation in *B. subtilis*, role of sigma factors in sporulation. Role of sigma factor in Regulation of lytic and lysogenic pathway in phage, Expression and regulation of early and late genes, Role of upstream activating sequences and regulatory proteins.

Regulation of eukaryotic gene expression: Levels of gene regulation, DNA binding proteins. Chromatin remodelling. Translational control of gene expression. Gene silencing- anti-sense RNA, RNAi. Protein degradation and turnover

Textbooks:

1. Watson JD. et al. (2014) Molecular Biology of the Gene, Pearson Education, Inc USA
2. Bruce A. et al (2007) Molecular Biology of the Cell, 5th edition, Garland science, New York, USA**.**

Reference books:

1. Verma P.S. and Agarwal VK (2005) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology S. Chand & company Ltd. New Delhi India.
2. Hardin J et al. (2012) Becker'sWorld of the Cell VIII edn. Pearson Benjamin Cummings, San Francisco, USA.
3. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.
4. Robert F. Weaver, Molecular Biology 3rd Edition, McGraw-Hill, 2003.

Course Outcomes (COs):

After the completion of the course student will be able:

1. To compare the evolution of prokaryotic and eukaryotic cells and describes the structure and function of various cellular organelles, cell junctions and cytoskeleton. (PO-1 PSO-1 and PSO-2)
2. To account for the molecular mechanisms of Protein trafficking, cell division and the cell cycle and illustrate how extracellular signals can transmit into the cell interior. (PO-1 and PO-4 PSO-1 and PSO-2)
3. To acquire knowledge of DNA replication and differentiate various steps and mechanism involved replication of prokaryotic and eukaryotic DNA. (PO-1 and PO-2 PSO- 1 and PSO-2)
4. To compare and analyze mechanism of prokaryotic and eukaryotic transcription and translation. (PO-1 PSO- 1 and PSO-2)
5. To describe various levels of gene expression regulation and compare and contrast the mechanism involved in regulation prokaryotic and eukaryotic gene expression (PO 1 and PO-4 PSO- 1 and PSO-2)

BIOCHEMISTRY LAB

Course Code	**:** BTL37	**Credits:**	0:0:1
Contact Hours	**:** 14P		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. Samrat K and Dr. P. Dhamodhar		

LIST OF EXPERIMENTS

1. Preparation of buffers, molar and normal solutions.
2. Qualitative tests for Carbohydrates
3. Qualitative tests for Amino acids and Proteins.
4. Titration of Amino acids- Sorenson's formal titration.
5. Estimation of phenol by FC method.
6. Estimation of reducing Sugar by O-Toludine / DNS method.
7. Estimation of inorganic Phosphate by Fiske-Subbarao method.
8. Estimation of Amino acid by Ninhydrin method.
9. Estimation of Protein by Lowry's method/Biuret method
10. Estimation of Urea by Diacetyl Monoxime method.
11. Estimation of Iron by Wong's method.
12. Determination of Saponification value of Lipids.
13. Determination of Iodine value of Lipid.
14. Determination of total carbohydrate by Anthrone method

Note: Any 12 experiments must be performed

Reference Books

1. Sadasivam S, Manickam A (2005) Biochemical Methods. Revised Second Edition, New Age International Pvt. (L.) Publisher.
2. Artinigam, Archana Ayyagari (2008). Lab Manual in Biochemistry, Immunology and Biotechnology, Tata Mac Graw Hill- Publishing company Ltd.

Course Outcomes (COs):

On completion of this course student will have improved ability to:-

1. Use of theories, principles and calculation for chemical reagents preparation to conduct the experiments. (PO-2, 3; PSO-2)
2. Design and enhance the practical approaches in estimation of carbohydrates, proteins and lipids. (PO-2, 3, 10; PSO-2)

3. Formulate and evaluate the experimental methods used in biochemistry research laboratory. (PO-2, 3, 10; PSO-2)
4. Use of the applicability of the biochemical methods to realistic situations. (PO-2, 3, 4; PSO-2)
5. Will gain proficiency in basic laboratory techniques in both chemistry and biology, and be able to apply the scientific method to the processes of experimentation. (PO-2, 3, 10; PSO-2)

MICROBIOLOGY LAB

Course Code	**:** BTL38	**Credits:**	0:0:1
Contact Hours	**:** 14P		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. Ahalya N & Dr. Priyadarshini Dey		

LIST OF EXPERIMENTS

1. Preparation of media for the cultivation of bacteria and fungi
2. Hanging drop experiment to study motility
3. Micrometry
4. Gram's staining of bacteria
5. Lactophenol cotton blue mounting of fungi
6. Enumeration of total count of microorganisms using haemocytometer
7. Isolation and enumeration of bacteria from soil by the serial dilution-agar plating method
8. Biochemical identification of microorganisms I- Catalase test, starch hydrolysis test, carbohydrate fermentation
9. Biochemical identification of microorganisms II- IMViC tests
10. Methods of obtaining pure cultures of microorganisms (Streak-plate method, pour-plate method and spread plate technique)
11. Most probable number (MPN) analysis
12. Antibiotic susceptibility testing of a bacterium
13. Lactic acid fermentation
14. Growth curve of bacteria (Demonstration)

Note: Any 12 experiments must be performed

Reference Books:

1. John Harley (2016) Laboratory Exercises in Microbiology, 10th Edn., Harley, McGraw-Hill, USA.
2. James G. Cappuccino, Natalie Sherman (2014) Microbiology: A Laboratory Manual, 10th Edn., Pearson.
3. Aneja KR (2010) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edn., New Age International Publication.

Course outcomes (COs):

On completion of the course, student will have improved ability to:

1. Operate equipment used in microbiology laboratory. (PO-1, 2, 3, 12; PSO-1)
2. Prepare growth media and isolate microorganisms from various sources. (PO-1, 2, 3, 12; PSO1)
3. Perform aseptic transfers of microorganisms. (PO-1, 2, 3, 12; PSO-1)
4. Identify microorganisms using morphological and physiological tests. (PO-1, 2, 3, 12; PSO-1)
5. Carry out antibiotic susceptibility testing of bacteria. (PO-1, 2, 3, 12; PSO-1)

ADDITIONAL MATHEMATICS – I

Course Code	**:** AM31	**Credits:**	0:0:0
Contact Hours	**:** 40L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. N L Ramesh		

Course Objectives:

1. Learn successive differentiation, polar coordinate system and Taylor's series expansion of functions of single variable.
2. Learn the concept of reduction formula and multiple integrals.
3. Study vector algebra and vector differentiation.
4. Learn the procedure of solving first order and first degree ODE's.

Unit-I

Differential Calculus-I -08 Hrs

Successive differentiation, n^{th} derivatives of some standard functions, Leibnitz theorem, Polar curves. Angle between the radius vector and the tangent, angle between curves, length of the perpendicular from pole to the tangent, pedal equations. Taylor's and Maclaurin's expansions.

Unit-II

Integral Calculus -08 Hrs

Introduction, Reduction formula, Reduction formula for $\int sin^n x\, dx$, Reduction formula for $\int cos^n x\, dx$, Reduction formula for $\int sin^n x cos^m x\ dx$, Evaluation of double and triple integrals.

Unit-III

Vector Algebra-08 Hrs

Scalar and vectors. Vector addition and subtraction. Multiplication of vectors (Dot and Cross products). Scalar and vector triple product-simple problems. Vector functions of a single variable. Derivative of a vector function, geometrical interpretation. Velocity and acceleration.

Unit –IV

Vector Differentiation-08Hrs

Scalar and vector fields, gradient of a scalar field, directional derivative, divergence of a vector field, solenoidal vector, curl of a vector, irrotational vector,Laplace's operator. Vector identities connected with gradient, divergence and curl.

Unit- V

First Order Differential Equations-08 Hrs

Solution of first order and first degree differential equations, variable separable methods, homogeneous equations, linear and Bernoulli's equations, exact differential equations.

Text Books:

1. B.S. Grewal – Higher Engineering Mathematics, Khanna Publishers, 44thedition, 2017.
2. Erwin Kreyszig –Advanced Engineering Mathematics, Wiley publication, 10th edition, 2015.

References:

1. H.K. Dass – Higher Engineering Mathematics – S Chand Publications - 1998.
2. B.V. Ramana – Engineering Mathematics – Tata McGrawHill Publishing Co. Ltd. – New Delhi – 2008.

Course Outcomes (COs):

At the end of the course the student will be able to

1. Find the length of the perpendicular from pole to tangent and determine the series expansion of differentiable functions (PO-1, 2)
2. Evaluate multiple integrals (PO-1, 2)
3. Analyze and solve problems related to Vector Algebra. (PO-1, 2)
4. Apply vector differentiation to identify solenoidal and irrotational vectors. (PO-1, 2)
5. Solve the first order and first degree ordinary differential equations. (PO-1, 2)

BIOSTATISTICS AND BIO MODELING

Course Code	**:** BT41	**Credits:**	3:1:0
Contact Hours	**:** 42L+14T		
Prerequisite(s)	**:** Calculus & Probability		
Course Coordinator(s)	**:** Dr. Monica Anand & Dr. Ramprasad S		

UNIT-I

Random variables and Probability distributions: Random variables, Discrete and continuous random variables, Mean and variance, Binomial distribution, Poisson distribution, Geometric distribution, Exponential distribution, Uniform distribution, Normal distribution.

UNIT-II

Joint Probability Distributions: for discrete and continuous random variables, Conditional and marginal distributions

Stochastic Process: Classification, Unique fixed probability vector, Regular stochastic matrix, Transition probability matrix, Markov chain.

Genetic application of probability: Genetic Applications of Probability, Hardy - Weinberg law, multiple alleles and application to blood groups.

UNIT-III

Sampling and Statistical inference: Sampling distributions, Concepts of standard error and confidence interval, Central Limit Theorem, Type 1 and type 2 errors, Level of significance, One tailed and two tailed tests, Z-test: for single mean, for single proportion, for difference between means, Student's t –test: for single mean, for difference between two means, F – test: for equality of two variances, Chi-square test: for goodness of fit, for independence of attributes

UNIT-IV

ANOVA and Optimization models: Analysis of variance (One way and Two-way classifications): Case studies of statistical designs of biological experiments (RCBD and RBD), Single and double – blind experiments, Limitations of experiments, Optimization models in Biology and Medicine – Medical diagnosis problem, Hospital diet problem.

UNIT-V

Biomodeling: Microbial growth in a chemostat, Growth equations of microbial populations, Models of commensalisms, Mutualism, Predation and Mutation,

Population Models: Single Species logistic equation, simple prey-predator model, Multispecies population model: Lotka - Volterra's model for *n* interacting species, Basic models for inheritance, Selection and Mutation models, Genetic inbreeding models – Selfing, Sibmating.

Text Books:

1. Marcello Pagano and Kimberlee Gauvreau – Principles of Biostatistics – Thompson Learning – 2nd edition – 2007.
2. B.S. Grewal – Higher Engineering Mathematics – Khanna Publishers – 44thedition – 2017.
3. J. N. Kapur – Mathematical Models in Biology and Medicine- East-West Press Private Ltd. – New Delhi – 2010.

Reference Books:

1. Murray R. Spiegel, John Schiller, R. Alu Srinivasan – Schaum's Outline of Probability and Statistics – The McGraw hill Company – 4th edition - 2016
2. Warren J. Ewens, Gregory R. Grant – Statistical Methods in Bioinformatics: An Introduction – Springer Publications – 2nd edition – 2006.
3. Wayne W. Daniel – Biostatistics: A Foundation for Analysis in the Health sciences – John Wiley & Sons – 10th edition – 2014.

Course Outcomes (COs):

At the end of the course, the student will be able to

1. Analyze the given random data and its probability distribution (PO-1,2; PSO-2).
2. Calculate the marginal and conditional distributions of bivariate random variables and apply the concept of Markov Chain in the prediction of future events and the probable characteristics possessed by the off springs of the n*th* generation (PO-1,2; PSO-2).
3. Choose an appropriate test of significance and make inference about the population from a sample (PO-1,2; PSO-2).
4. Use one way and two-way ANOVA to compare sample means (PO-1,2; PSO-3).
5. Explain various genetic models and biological phenomena mathematically (PO-1,2; PSO-23).

HEAT & MASS TRANSFER

Course Code	**:** BT42	**Credits:**	4:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Unit Operations		
Course Coordinator(s)	**:** Dr. Samrat K and Dr. Chandraprabha M N		

UNIT-I

Introduction to Heat Transfer: Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer plane wall sphere, cylinder; Insulation – types, critical radius, Optimum thickness of insulation. Forced and Natural convection; Significance of Dimensionless numbers (Nu, Gr, Pr, Re, Pe numbers only); Heat transfer without phase change, heat transfer in laminar and turbulent flow inside closed conducts, concepts of film heat transfer coefficients.

UNIT-II

Heat Transfer Equipment: Equations and numerical problem for calculations of film heat transfer coefficients, Heat transfer with phase change - Condensation – film wise and drop wise; Boiling – types of boiling. Co current and counter current flow. Individual and overall Heat transfer coefficients, LMTD, Elementary design of double pipe heat exchanger and shell and tube heat exchanger.

UNIT-III

Basics of Mass Transfer: Diffusion - Fick's law of diffusion. Measurement of diffusivity, Theories of mass transfer, Mass transfer coefficients and their correlations. Liquid-Liquid, Solid-Liquid, Liquid-Gas, Solid-Liquid-Gas Mass transfer. Individual and Overall Mass Transfer Coefficients.

UNIT-IV

Mass transfer Operations-I

Distillation: Methods of distillation –Simple, Flash distillation of binary mixtures – relative volatility, fractionation of binary mixtures -McCabe Thiele method, Extractive and Azeotropic distillation, numerical.

Drying: Drying rate, drying curve and calculations, drying equipment.

UNIT-V

Mass transfer Operations-II

Principles, mass transfer considerations, design equations and equipments for leaching, extraction, absorption, adsorption, crystallization and evaporation

Textbooks:

1. McCabe WL, Smith JC and Harriott (2005) Unit operations in Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA.
2. Treybal RE (2012) Mass Transfer Operations, 3rd Edition, McGraw-Hill Publications, USA.
3. R. P. Chhabra V. Shankar (2018) Coulson and Richardson's Chemical Engineering Volume 1B: Heat and Mass Transfer: Fundamentals and Applications, 7th Edition, Butterworth-Heinemann.

Reference Books:

1. Pauline Doran (2012) Bioprocess Engineering Principles, 2nd Edition, Academic Press.
2. Alan S Foust, Wenzel LA, Clump CW, Maus L and Anderson LB (2008). Principles of Unit Operations, 2nd Edn., John Wiley & Sons, USA.
3. Ann Marie Flynn, Toshihiro Akashige, Louis Theodore (2019) Kern's Process Heat Transfer, 2nd Edn. John Wiley & Sons, Inc.
4. Perry RH and Green DW (2008). Perry's Chemical Engineering Handbook, 8th Edn., McGraw- Hill Publications.

Course Outcomes (COs):

On completion of this course student will have improved ability to:

1. Determine heat flux and temperature distribution in steady state one-dimensional problems using thermal resistance concept. (PO-1, 2; PSO-1)
2. Estimate the heat transfer rate for different types of heat exchangers. (PO-2, 3; PSO-3)
3. Predict mass transfer rates and mass transfer coefficients. (PO-2, 3, 4, 5; PSO-3)
4. Estimate the number of theoretical plates required for effective separation of liquid mixtures. (PO-2, 3, 4; PSO-3)
5. Determine various parameters of mass transfer operations. (PO-2, 3, 4; PSO-3)

BIOCHEMICAL THERMODYNAMICS

Course Code	**:** BT43	**Credits:**	3:1:0
Contact Hours	**:** 42L+14T		
Prerequisite(s)	**:** Bioprocess principles & Calculations		
Course Coordinator(s)	**:** Dr. Chandraprabha M N & Mr. Gokulakrishnan M		

UNIT-I

Introduction: System, surrounding & processes, closed and open systems, intensive & extensive properties, state and path functions, equilibrium state, reversible and irreversible processes. First law of thermodynamics**:** general statement of first law of thermodynamics, first law for cyclic process, non-flow process, flow process.

UNIT-II

Second law of thermodynamics & P-V-T behaviour: General statement of the second law, concept of entropy, the Carnot principle, calculation of entropy changes, Clausius inequality, entropy and irreversibility, third law of thermodynamics. P-V-T behaviour of pure fluids, equations of state and ideal gas law, processes involving ideal gas law: constant volume, constant pressure, constant temperature, adiabatic and polytropic processes. Equations of real gases, principles of corresponding states, compressibility charts.

UNIT-III

Thermodynamic Properties of Pure Fluids: Derived properties, work function, Gibbs free energy, relationships among thermodynamic properties. Fundamental property relations, Maxwell's relations, Clapeyron equation, entropy-heat capacity relation, Effect of temperature on U, H & Entropy (S), relationships between Cp & Cv, Gibbs-Helmholtz equation. Fugacity, fugacity coefficient, Determination of fugacity of pure gases, fugacities of solids and liquids. Activity and activity coefficient, Thermodynamic diagrams. Properties of solutions.

UNIT-IV

Properties of Solutions & Phase Equilibria: Partial molar properties, Chemical potential, Gibbs-Duhem equation & its applications, Henry's law & Raoult's law. Criteria of phase Equilibria, criterion of stability, Duhem's theorem, Vapour- Liquid Equilibria: VLE in ideal solutions, Consistency test for VLE data, calculation of activity coefficients using Gibbs - Duhem equation, Liquid-Liquid Equilibrium diagrams.

UNIT-V

Biochemical Energetics: Reaction Stoichiometry, criteria of biochemical reaction equilibrium, equilibrium constant and standard free energy change, effect of temperature on equilibrium constant, factors affecting equilibrium conversion. Concept of pH and ionization of biochemicals, Ligand binding to substrate, Membrane transport (Gibbs Donnan equation), Energy coupling reactions (ATP and NADH), Energetics of metabolic pathways (Glucose metabolism, Photosynthesis).

Textbooks:

1. J. M. Smith, H. C. Van Ness, M. M. Abbott, M. T. Swihart, B. I. Bhatt (2018) Introduction to Chemical Engineering Thermodynamics, 8th Edition, McGraw Hill Publications, USA.
2. Stanley I. Sandler (2017) Chemical, Biochemical, and Engineering Thermodynamics, 5th Edn., John Wiley & Sons, USA.
3. Narayanan KV (2013) A Textbook of Chemical Engineering Thermodynamics, 2nd Edn., Prentice Hall Publication, India.

Reference Books:

1. Bailey JE and Ollis DF (2010) Biochemical Engg. Fundamentals, 2nd Edition, McGraw Hill, New York, USA.
2. Rao YVC (1997) Chemical Engineering Thermodynamics, New Age International, India.
3. Segel IH (1993) Biochemical Calculations, 2nd Edn., John Wiley & Sons, USA.
4. Shuler ML and Kargi F (2001) Bioprocess Engineering, 2nd Edn., Prentice Hall International, USA.
5. David Nicholls L (2013) Bioenergetics, 4th Ed. Academic Press, New York.

Course Outcomes (COs):

On completion of this course student will have improved ability to,

1. Explain the fundamental concepts of the laws of thermodynamics and apply the first law of thermodynamics to solve engineering problems. (PO-1, 4; PSO-1)
2. Apply second law of thermodynamics and P-V-T behaviour of pure fluids to solve engineering problems. (PO-1, 3, 4; PSO-1)
3. Estimate the thermodynamic properties, such as enthalpies, entropies, Gibb's energies, fugacity coefficients, and activity coefficients of pure fluids as well as fluid mixtures. (PO-1, 2, 3, 4; PSO-1)
4. Predict equilibrium compositions of mixtures under phase. (PO-1, 2, 3, 4; PSO-1, 3)
5. Predict the feasibility and equilibrium constant of chemical reactions and explain the energetic of metabolic pathways. (PO-1, 4; PSO-1, 3)

GENTICS AND GENETIC ENGINEERING

Course Code	**:** BT44	**Credits:**	4:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Cell and Molecular Biology		
Course Coordinator(s)	**:** Dr. Ravikumar Y S and Dr. Prabha M		

UNIT-I

Introduction & scope of Genetics: Mendel's principles, gene interaction and linkage, multiple alleles– blood groups and Rh factor, X linked inheritance, DNA organization in chromosomes, extra nuclear inheritance, genetic recombination in bacteria and DNA recombination in eukaryotes,

UNIT-II

Gene Mutation, and Transposition Chromosome Mutations: Variation in number and arrangement DNA repair, Cancer genetics: mutation of DNA repair, chromatin modifications, proto-oncogenes and tumour-suppressor genes. Developmental genetics, modern genetics, epigenetics, roles of RNA in genetics, catalytic RNA, noncoding RNAs.

UNIT-III

Introduction to Genetic Engineering: Role of genes within cells, genetic elements that control gene expression, scope and applications of genetic engineering. Extraction and purification of DNA. Enzymes in genetic engineering– restriction endonucleases, polymerases, ligases, alkaline phosphatase, RNase, topoisomerases. modifying enzymes, DNase, linkers and adaptors. Vectors in recombinant DNA technology – bacterial plasmids, cosmids, viruses and artificial chromosomes. Cloning host systems.

UNIT-IV

Construction of genomic and cDNA libraries: cDNA Synthesis-mRNA enrichment, reverse transcription. Molecular Cloning strategies: Generation of DNA fragmentation, joining of DNA fragments to vectors, delivery/introduction of recombinant molecules into the selected host cells by biological and non-biological means, screening of DNA libraries for clone identification. Polymerase chain reaction (PCR). Blotting techniques-southern, northern, western blotting. DNA Sequencing. DNA finger printing.

UNIT-V

Genome editing and applications genetic engineering: Genome editing- An Overview of Gene Editing Tools: Zinc Finger Nucleases, TALENS, and CRISPR/Cas9

system. Transgenic science: engineering microbes for the production of Insulin, Growth Hormones and Monoclonal Antibodies, Production of recombinant protein by eukaryotic cells Recombinant protein from yeast and animal cells. recombinant protein from live animals and Plants, Genetic manipulation of animals, Applications of genetically modified animals. Transgenic plant: Production of BT and Herbicide resistant crops, Antisense RNA technology.

Text books:

1. Pierce BA. (2012), Genetics A Conceptual Approach IV edn. W. H. Freeman and Company New York
2. W. Old & Primrose; Principles of Gene Manipulation. S.B. University Press, 6th edition, 2001.
3. T.A. Brown. Gene cloning and DNA analysis: an introduction, 6th ed. 2010.

Reference books:

1. T. Maniatis, E.F. Fritsch & J. Sambrook; Molecular Cloning: A Laboratory Manual. CSHL, 3rd edition, 2002.
2. Verma P.S. and Agarwal VK (2005) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology S. Chand & company Ltd. New Delhi India.

Course Outcomes (COs):

After the completion of the course student will be able:

1. To account for basic concepts of hereditary, variation and describe mechanism of Genetic Recombination in prokaryotic and eukaryotic organisms. (PO-1, 2, 4, 6, 12; PSO-1, PSO-2)
2. To classify and recognize mutation, the causes and its types and analyze mechanism of cancer and epigenetics. (PO-1 PSO-1 PSO- 2)
3. To apply the properties of various enzymes and vectors in gene and genome manipulation. (PO- 1, PO-3, PO- 5 PSO-1 and PSO-2)
4. To execute different techniques used in the construction and screening of genomic library. (PO- 3 and PO-5 PSO-1 and PSO-2)
5. To describe mechanism of Genome editing and apply knowledge recombinant DNA technology for the development of industrial products and process. (PO-1 and PO-4 PSO-1 and PSO-2)

BIOPHYSICS & STRUCTURAL BIOLOGY

Course Code	**:** BT45	**Credits:**	4:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Biochemistry		
Course Coordinator(s)	**:** Dr. Abhijith S R & Dr. P Dhamodhar		

UNIT-I

Introduction to Structural Biology: History and importance of Structural Biology. Levels of molecular organization: atom-to-cell-to-organism. Structure & properties of water. Isomerism- conformational & configurational isomers. Chirality of biological molecules. Amino acid structures, introduction to primary structure of proteins, torsional/dihedral angles, properties of peptide bond**.** Nucleic acids-General characteristics of nucleic acid structures, geometries, glycosidic bond, phosphodiester linkage.

UNIT-II

Structural characteristics of proteins: Secondary structures: helix, beta sheet, turns and loops. Ramachandran steric contour diagram. Tertiary, Quaternary structures of proteins-example of haemoglobin. Forces that stabilize protein structures. Protein folding- Levinthal's paradox, Anfinsen experiment, termodynamic aspects of protein folding, molecular chaperons in protein folding. Globular and Fibrous proteins: structure of myoglobin, structure of collagen.

UNIT-III

Structure of Nucleic acids and Biomembranes: Nucleic acid structures, stabilizing ordered forms of DNA (A, B and Z), base pairing types, base stacking, tertiary structure of DNA and preferred torsion angles. Ribose puckering and structure of tRNA. Structure & conformational properties of cell membranes. Membrane proteins-conformational variations during ion transport. Structure and function of ATPase.

UNIT-IV

Introduction to Biophysics and Biophysical Techniques: Introduction to Biophysics, movement of molecules, Brownian movement, Diffusion, Molecular motors, Membrane potential, Voltage clamp. Light Scattering: principles of Static and Dynamical light scattering, DLS applications. Fluorescence & Phosphorescence, Photobleaching, Fluorescence Resonance Energy Transfer (FRET), Applications of FRET, Surface Plasmon Resonance (SPR), Isothermal Titration Calorimetry (ITC), Live-cell imaging, Super-resolution microscopy.

UNIT-V

Biomolecular structure determination: Polarized light, Linear & Circular Dichroism (CD), Applications of CD. Structure determination methods: Single crystal X-ray diffraction method- protein crystal growth methods, Data collection, Phase problem, Phase determination methods. Nuclear Magnetic Resonance (NMR) - Principal and steps involved in solving structures by NMR. Introduction to Cryo Electron Microscopy

Textbooks:

1. Narayanan P (2000), Essentials of Biophysics, New Age International Publishers.
2. Van Holde, Curtis Johnson, Shing Ho (2006), Principles of Physical Biochemistry, 2nd Edition, Pearson Prentice Hall.
3. Nelson DL and Cox MM (2013) Leninger Principles of Biochemistry, 6th edition, W.H. Freeman.

Reference Books:

1. Bengt Nölting (2006) Methods in Modern Biophysics. 2nd edn., Springer Berlin Heidelberg New York.
2. Cantor CR and Schimmel PR (1980), Biophysical Chemistry: Part I, The Conformation of Biological Macromolecules, W. H. Freeman

Course Outcomes (COs):

On completion of this course student will have improved ability to: -

1. Apply the principles of stereochemistry to macromolecular structures. (PO-1, 4; PSO-1)
2. Correlate the relationship between primary structure and higher order structures of proteins. (PO-1, 2, 5; PSO-1)
3. Analyse the nucleic acid and biomembrane structures. (PO-1, 2, 4, 5; PSO-2)
4. Compare the working principle of various biophysical techniques and apply them to characterize macromolecules. (PO-1, 3, 4, 10; PSO-3)
5. Appraise the role of biophysical techniques in protein structure determination. (PO-4, 5, 10; PSO-3)

BIOANALYTICAL TECHNIQUES

Course Code	**:** BT46	**Credits:**	3:0:0
Contact Hours	**:** 42L		
Prerequisite(s)	**:** Engineering Physics and Engineering Chemistry		
Course Coordinator(s)	**:** Dr. Ahalya N & Dr. Abhijith S R		

UNIT-I

Introduction and Basic Spectroscopy: Types & Basic concepts of analytical methods. Preparation and standard solutions and buffers. pH and Oxygen electrodes. Electromagnetic radiation - its properties and interaction with matter. Emission of radiation. An introduction to absorption spectroscopy, photometry, beer lamberts law UV, visible, IR spectrophotometry theory and instrumentation, Turbidometry & Nephelometry: Principle & Applications.

UNIT-II

Advanced Spectroscopy: Spectrofluorimetry: Principles & Applications. Flame Emission and Atomic Absorption Spectroscopy: Principles & Instrumentation. NMR Spectroscopy: Principles, Instrumentation, Applications; Mass Spectrometry: Principles, Instrumentation, and applications. Flow Cytometry (FCM): Principle and Applications

UNIT-III

Centrifugation: Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.

UNIT-IV

Chromatography: Distribution coefficient, modes of chromatography; Thin Layer Chromatography, Molecular Exclusion chromatography: Principles, Instrumentation, Applications, Ion Exchange and Affinity chromatography – Principles & Applications Gas liquid chromatography: Principles, Instrumentation, Applications. High Pressure Liquid Chromatography (HPLC): Principles, Instrumentation, Applications.

UNIT-V

Electrophoresis: General principles, Support media, Electrophoresis of proteins – SDS PAGE, Native PAGE, Gradient gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Electrophoresis of Nucleic acids- Agarose Gel Electrophoresis.

Textbooks:

1. Avinash Upadhyay, Kakoli Upadhyay, Nirmalendu Nath (2009) Biophysical Chemistry, Himalaya Publishing House, India.
2. Keith Wilson, John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, USA.

Reference books:

1. Campbell ID and Durek RA (1984) Biological Spectroscopy, 1st Edition., Benjamin-Cummings Publishing Company, USA.
2. John Kenkel (1994) Analytical chemistry for technicians, Lewis publishers, Boca.
3. Sadasivam S and Manickam A (1991) Biochemical Methods, 3rd Edition., New Age International Publishers, India.
4. Plummer DT (2004) Practical Biochemistry, Tata McGraw Hill Publications, India
5. Channarayappa (2006) Molecular Biotechnology: principles and practices, Universities Press (India) Pvt. Ltd., CRC Press Worldwide.

Course Outcomes (COs):

On completion of this course student will have improved ability to-

1. Apply the new emerging technologies in the field of analytical techniques. (PO-1,2, 4, 5; PSO-1)
2. Select the appropriate spectroscopic technique for a particular biological, chemical or environmental sample. (PO-2, 4, 5; PSO-1)
3. Use centrifugation techniques for various applications. (PO-2, 4, 5; PSO-1)
4. Separate and purify biological samples using chromatographic techniques. (PO-4,5; PSO-1)
5. Describe the techniques of electrophoresis. (PO-4, 5; PSO-1)

CELL & MOLECULAR BIOLOGY LAB

Course Code	**:** BTL47	**Credits:**	0:0:1
Contact Hours	**:** 14P		
Prerequisite(s)	**:** Cell and Molecular Biology		
Course Coordinator(s)	**:** Dr. Abhijith S R and Dr. Y S Ravikumar		

LIST OF EXPERIMENTS

1. Study of cell structure (Prokaryotes & Eukaryotes).
2. Study of mutants of Drosophila and maintenance /special chromosome
3. Study of Mitotic stages by Squashing Technique (Onion root tips).
4. Study of Meiotic stages in *Allium cepa*
5. Isolation of genomic DNA (plant / animal/ microbial sources – any one).
6. Quantification of nucleic acids by spectrophotometric, Gel and by densitometry methods.
7. Polymerase Chain Reaction (Programming and working).
8. Agarose gel electrophoresis of DNA.
9. Restriction mapping (Single or double digestion).
10. Isolation of plasmid DNA
11. Replica plating method
12. DNA Ligation
13. Bacterial conjugation
14. Extraction of DNA figments from Agarose gel (column or solution-based method)

Note: Any 12 experiments must be performed

Reference Books

1. Channarayappa (2015) Molecular Biology: Universities Press (India) Pvt Ltd.
2. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, and Walters P (2002) Molecular biology of the cell, 4th Edn. Garland Science. New York & London.
3. Karp G (2005) Cell and Molecular Biology: concepts and experiments, 4th Edn, John Wiley & Sons, Inc.
4. Cooper GM and Hausman RE (2006) The Cell: A Molecular Approach, 4th Edn. ASM Press and Sinauer Associates

Course Outcomes (COs):

On completion of this course student will have improved ability to:-

1. Demonstrate the knowledge of common and advanced laboratory practices in cell and molecular biology. (PO-2,3,10; PSO-2)
2. The ability to conduct observations and experiments including DNA/RNA/protein. (PO-2,3,10; PSO-2)
3. Able to conduct and analyze extraction and electrophoresis. (PO-2,3,10; PSO-2)
4. Demonstrate advanced laboratory bench skills, lab notebook record keeping, and team work. (PO-2,3,9,10; PSO-2)
5. Exhibit clear and concise communication of scientific data. (PO-2,3,10; PSO-2)

UNIT OPERATIONS LAB

Course Code	**:** BTL48	**Credits:**	0:0:1
Contact Hours	**:** 14P		
Prerequisite(s)	**:** Unit Operations		
Course Coordinator(s)	**:** Dr. Samrat K and Dr. Chandraprabha M N		

LIST OF EXPERIMENTS

1. Friction in circular pipes.
2. Flow rate measurement using orificemeter.
3. Flow rate measurement using venturimeter.
4. Study of pump characteristics.
5. Determination of screen effectiveness.
6. Determination of minimum thickener area using batch sedimentation tests.
7. Size reduction using ball mill.
8. Diffusion of organic vapours in air.
9. Simple Distillation.
10. Drying Characteristics.
11. Single & Multi stage extraction.
12. Adsorption studies.
13. Critical radius of insulation.
14. Vertical condenser.

Note: Any 12 experiments must be performed.

Reference Books

1. Alan S Foust, Wenzel LA, Clump CW, Maus L, and Anderson LB (2008). Principles of Unit Operations. 2nd Edn., John Wiley & Sons, USA.
2. Coulson and Richardson's (2011); Chemical Engineering, Vols I & II., 6th Edn., Reed Educational and Professional Publishing Ltd., USA.

Course Outcomes (COs):

On completion of this course student will have improved ability to:-

1. Estimate the pressure, drop, friction factor and flow rate through circular conduits and annulus. (PO-1, 2; PSO-1)
2. Estimate the efficiency of various pump. (PO-1, 2, 4; PSO-1)
3. Analyse the particle size and predict the surface area of the particles and the thickener area. (PO-2, 3, 4; PSO-3)
4. Determine the mass transfer coefficient of mass transfer operations and the efficiency. (PO-2, 3, 4; PSO-3)
5. Predict the individual and overall heat transfer coefficients of condenser and heat exchangers. (PO-2, 3, 4; PSO-3)

ADDITIONAL MATHEMATICS – II

Course Code	**:** AM41	**Credits:**	0:0:0
Contact Hours	**:** 40L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. N L Ramesh		

Course Objectives:

The students will

1. Understand the concept of partial derivatives, composite functions and Jacobians.
2. Learn to evaluate line, surface and volume integrals.
3. Learn to use Laplace transform method to solve initial and boundary value problems.
4. Learn the procedure of solving Linear differential equations with constant and variable coefficients.
5. Study the concepts of basic probability.

Unit-I

Differential calculus - 08 Hrs

Partial differentiation, Euler's theorem, total differential coefficient, differentiation of composite and implicit functions, Jacobian and Properties. Taylor's theorem for function of two variables, maxima and minima for functions of two variables.

Unit-II

Vector integration – 08 Hrs

Line integrals, surface integrals and volume integrals. Green's theorem, Stokes' and Gauss divergence theorem (without proof) and problems, orthogonal curvilinear coordinates.

Unit-III

Laplace transforms - 08 Hrs

Definitions, Laplace transforms of elementary functions, derivatives and integrals, periodic function, unit step function, inverse transforms, applications of Laplace transform to solve differential equations.

Unit-IV

Higher Order Differential Equations - 08 Hrs

Higher order linear differential equations, method of variation of parameters, Cauchy's and Legendre's homogeneous differential equations.

Unit-V

Probability - 08Hrs

Introduction. Sample space and events. Axioms of probability. Addition and multiplication theorems. Conditional probability-illustrative examples. Bayes theorem –examples.

Text Books:

1. B.S. Grewal – Higher Engineering Mathematics, Khanna Publishers, 44thedition, 2017.
2. Erwin Kreyszig –Advanced Engineering Mathematics, Wiley publication, 10th edition, 2015.

References:

1. H.K. Dass – Higher Engineering Mathematics – S Chand Publications - 1998.
2. B.V. Ramana – Engineering Mathematics – Tata McGrawHill Publishing Co. Ltd. – New Delhi – 2008.

Course Outcomes (COs):

At the end of the course the student will be able to

1. Find Jacobian, extreme values and power series expansion of a function. (PO-1, 2)
2. Exhibit the interdependence of line, surface and volume integrals using integral theorems. (PO-1, 2)
3. Use the concept of Laplace transforms to solve initial and boundary value problems (PO-1, 2)
4. Solve Linear differential equations with constant and variable coefficients (PO-1, 2)
5. Demonstrate the understanding of axioms and rules of probability to solve problems. (PO-1, 2)